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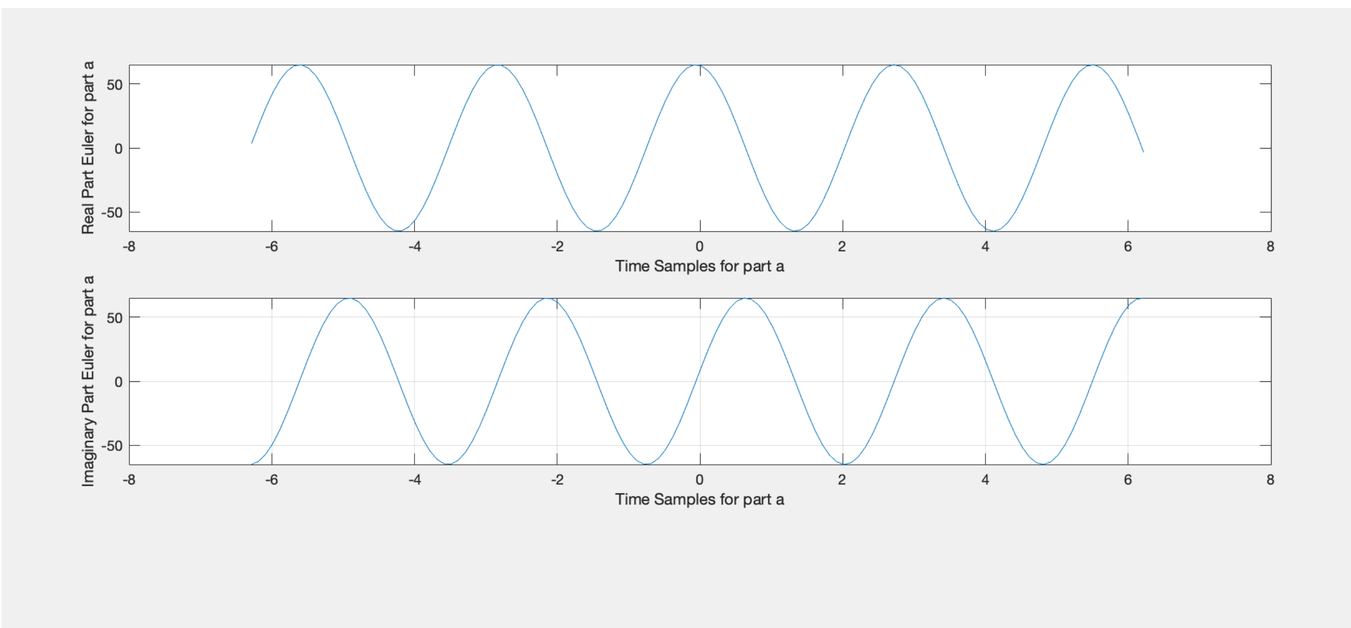
EEE 391 - Mini Project 1

- $v_k(t) = 65e^{j(2\pi k 018\, t + \phi)}$

- **Euler's Formula:** $e^{i\phi} = cos\phi + isin\phi$

a)

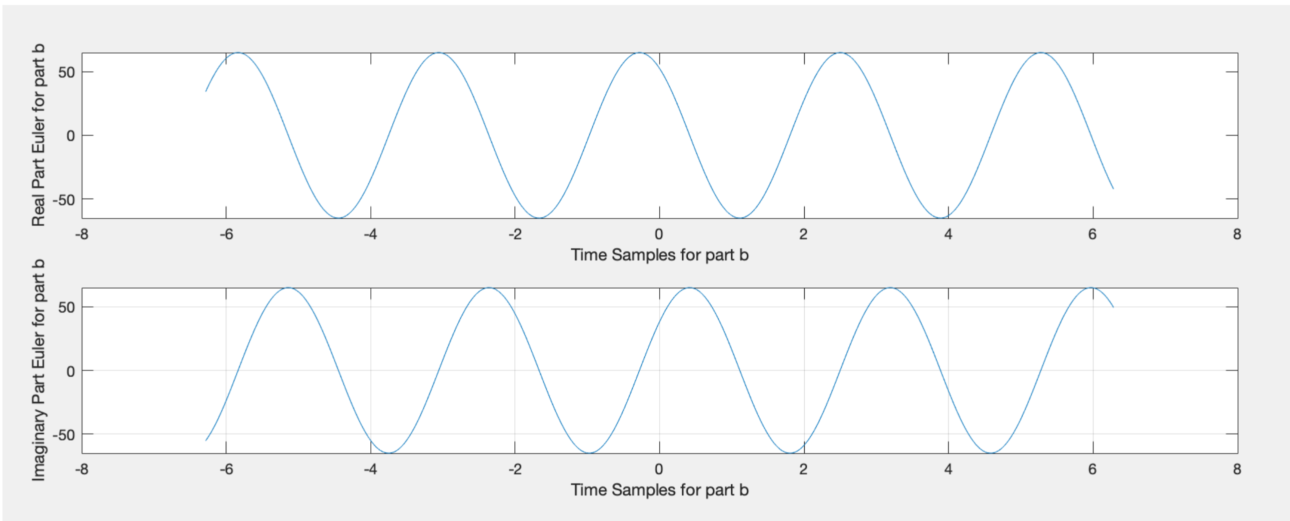


Values:

- **A value:** 65
- **k value**: 2
- f_0 **value:** 0.18

- ϕ **value:** 0.9134
- T_0 **value:** 10

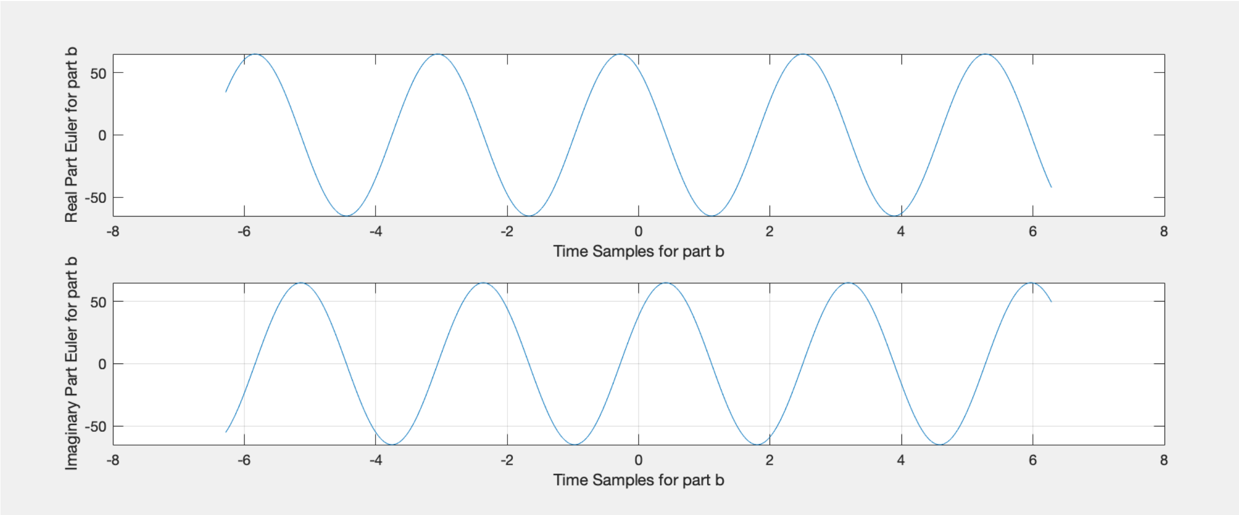
b)



Values:

- **1st T value:** 1000000

  Digital frequency: 1.1310e+03



- **2nd T value:** 1000

  Digital frequency: 1.1310e+03

Effect of changing T_s on the resulting sequence and on the digital frequency:

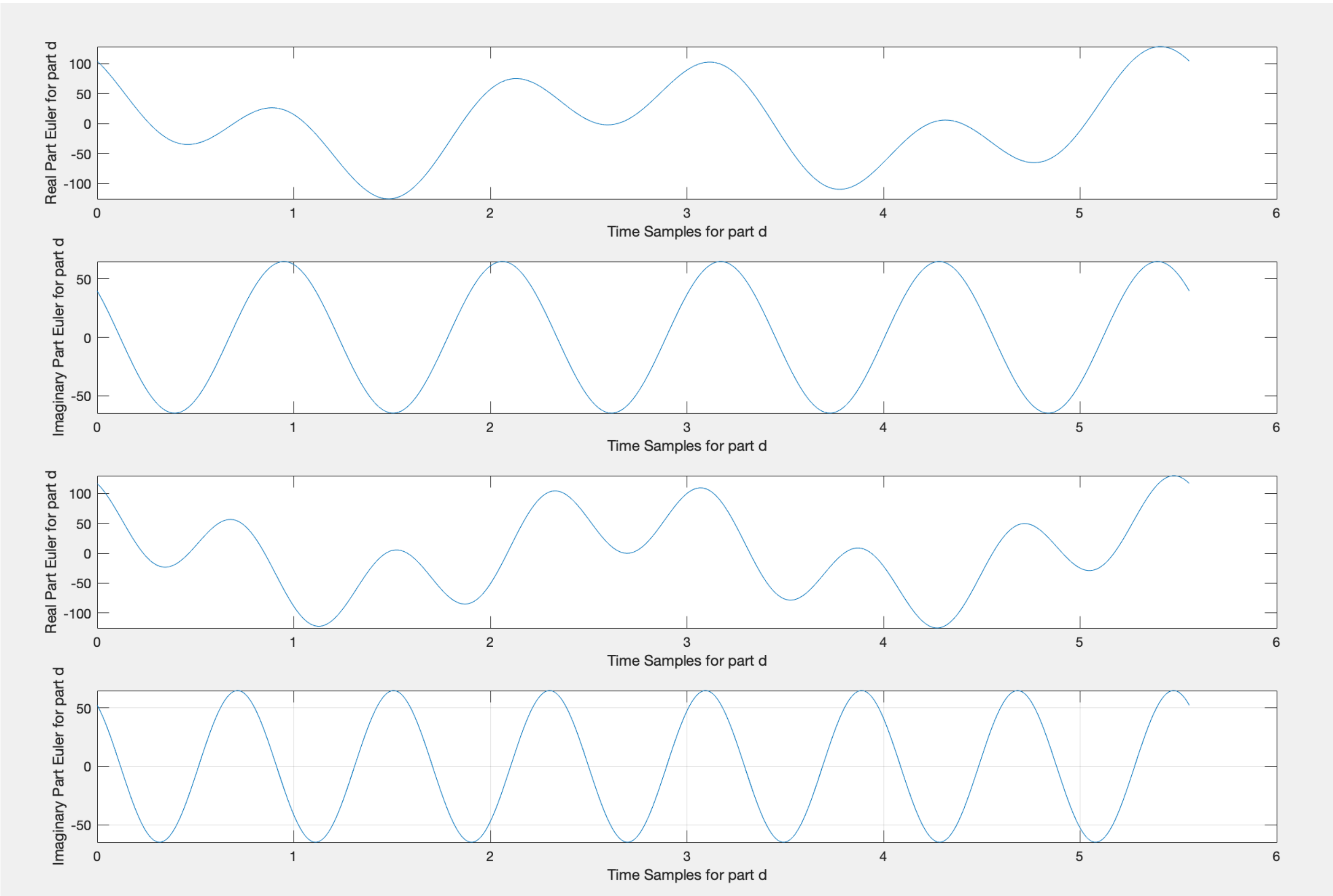
As can be seen from the above graph, two different time intervals have been used and other values were kept constant. First time value is 1000000 and second time value is 1000. The formula of digital frequency is calculated by multiplying the radian frequency and interval period. Since the radian frequency is the same for both cases, interval period causes an increase on digital frequency.

c) After adding up the values of real and imaginary parts for one fundamental period, following values have come up:

- Sum of real values: 13.389
- Sum of imaginary values: 3.89

However, 0 was expected to be gotten for both sum values because the sum for one fundamental period is calculated and there exists a negative value for each positive one. However, the sample is discrete (not continuous). Therefore, 0 is not achieved.

d)



Values:

- f_0 **= 0.18;**
- **A = 65;**

- k_1 **= 2;**
- k_2 **= 5;**
- k_3 **= 7;**
- T_s **= 10000;**

Yes, the sum converges to 0 as the summation interval is increased because waves in the plots have a + point as well as a - point which correspond to each other. Therefore, when the wave number increases, the sum converges to 0 further.

e) As the number of periods has increased, it can be observed that the value will converge to 0. The orthogonality principle states that if the two k values are not the same, then the value obtained will be 0. Therefore, the orthogonality principle can be related to the observations of this question.

f) There exists a linear and direct correspondence between the fundamental period and the dot product of the equations. This can be confirmed by the orthogonality principle as well: If the periodicity of the two signals is the same, the value of the period of the signals must be obtained.

- MATLAB CODE-

```
clc;
close all;
%%PART A
f_0 = 0.18;
A = 65;
k = 2;
T_s = 10;
w = 2*pi*f_0;
digitalFrequency = T_s*w;
disp('The values for part a are:')
disp('Radian frequency: ')
disp(w);
disp('Digital frequency: ')
disp(digitalFrequency);
disp('Period: ')
disp(T_s);
disp('Phase: ')
disp(phase);
t0 = -2*pi;
t1 = 2*pi;
t = t0:(1/T_s):t1;
phase = rand;
v_t = A*exp(1i*(w*k*t+phase));
re = A*cos(k*w*t+phase);
im = 1i*A*sin(k*w*t+phase);
subplot(4,1,1)
plot(t,re);
xlabel('Time Samples for part a');
ylabel('Real Part Euler for part a');
subplot(4,1,2)
```

```
plot(t,re);
xlabel('Time Samples for part a');
ylabel('Real Part Euler for part a');
subplot(4,1,2)
plot(t,imag(im));
xlabel('Time Samples for part a');
ylabel('Imaginary Part Euler for part a');
grid
```

```
%%PART B
T_sb = 1000;
f_0 = 0.18;
A = 65;
k = 2;
w = 2*pi*f_0;
digitalFrequency_b = T_sb*w;
t0 = -2*pi;
t1 = 2*pi;
phase = rand;
t_b = t0:(1/T_sb):t1;

re_b = A*cos(k*w*t_b+phase);
im_b = 1i*A*sin(k*w*t_b+phase);

disp('The values for part b are:')
disp('Radian frequency: ')
disp(w);
disp('Digital frequency: ')
disp(digitalFrequency_b);
disp('Period: ')
disp(T_sb);

subplot(4,1,3)
plot(t_b,re_b);
xlabel('Time Samples for part b');
ylabel('Real Part Euler for part b');
```

```
subplot(4,1,4)
plot(t_b,imag(im_b));
xlabel('Time Samples for part b');
ylabel('Imaginary Part Euler for part b');

grid

%%PART C
T0 = 1/f_0;
v_t0 = A*exp(1i*(w*k*(t_b+T0)+phase));
```

```
%%PART D
f_0 = 0.18;
A = 65;
k1 = 2;
k2 = 5;
k3 = 7;
T_s = 10000;
w = 2*pi*f_0;

T0 = 1/f_0;

t = 0:(1/T_s):T0;
%%t = 0:(1/T_s):3*T0;
%%t = 0:(1/T_s):5*T0;
phase = rand;
phase2 = rand;
phase3 = rand;

v_t = A*exp(1i*(w*k1*t+phase));
v_t0 = A*exp(1i*(w*k2*t+phase2));
v_t1 = A*exp(1i*(w*k3*t+phase3));

subplot(4,1,1)
plot(t,real(v_t + v_t0));
xlabel('Time Samples for part d');
ylabel('Real Part Euler for part d');
```

```
subplot(4,1,2)
plot(t,real(v_t0));
xlabel('Time Samples for part d');
ylabel('Imaginary Part Euler for part d');

subplot(4,1,3)
plot(t,real(v_t + v_t1));
xlabel('Time Samples for part d');
ylabel('Real Part Euler for part d');

subplot(4,1,4)
plot(t,real(v_t1));
xlabel('Time Samples for part d');
ylabel('Imaginary Part Euler for part d');

grid
```